OPERATING INSTRUCTIONS

Model 35P Proof Chronograph

Oehler Research, Inc.
Post Office Box 9135, Austin, TX 78766
Phone 512.327.6900 sales@oehler-research.com

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Oehler Research, Inc.
Post Office Box 9135
Austin, Texas 78766

Telephone 512 / 327-6900
FAX 512 /327-6903
sales@oehler-research.com

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Take your Model 35P to the range, set it up, and shoot. If everything doesn't work perfectly, you can then read the instructions. Some read only this first page, but the rest of the book will help you get better results. We try to cram forty-plus years of chronograph experience and the essence of thousands of conversations with users into this little book. Thank you for buying our product; we look forward to hearing from you.

CONDENSED INSTRUCTIONS

- ➔ Mount the skyscreens on the rail. Use the dimples to get the correct spacing. Use thumbscrew with middle screen.
- ➔ Remove bolt and place rifle on rest. Aim at downrange target.
- ➔ Place the first stand approximately 8 feet from muzzle with the second stand approximately 4' farther downrange. Place skyscreen/rail assembly on stands with the long bolts fitting into tops of stands.
- ➔ Locate your head so that you look through the skyscreen window as you look into the muzzle and see a centered bore. Adjust height and position stands until all are centered on boresight line.
- ➔ Verify gun is sighted at target and thru skyscreen windows. Any shot hitting the target will pass through the skyscreen windows. Leave the fore end rest in position and you can change guns.
- ➔ Plug skyscreen cables into the M35. Plugging in the start cable turns the system on. Push reset button until you see **---0**.
- ➔ Fire through skyscreens. The shot number and then primary velocity will be displayed. It prints proof velocity, shot number, and primary velocity.
- ➔ If the *PROOF CHANNEL* detects an error, the display flashes and an asterisk is printed alongside the velocity. You can use the OMIT button to erase any velocity that you suspect is incorrect. Fire additional shots as desired.
- ➔ Push the SUMMARY button. Printer will show high, low, extreme spread, average or mean, and standard deviation for primary channel.
- ➔ Fire more shots to add to the same group, or push the RESET button to start a new group.

PROOF CHANNEL BACKGROUND

Professional users have long recognized the convenience of skyscreens. These same users have also recognized limitations in the reliability of skyscreens. With skyscreens you are at the mercy of the light conditions existing at the range. Skyscreens work well under most conditions, but under certain rare light conditions there will be errors. If you haven't yet found these conditions, you will. Errors are seldom, and users will forgive the system if the chronograph flags those shots that may contain errors. The proof channel in the Model 35P warns you of any measurement error.

If you set your screen spacing accurately, the proof velocities should be very near the primary velocities. The proof velocities are measured from start screen to the middle screen; the primary velocities are measured from start screen to stop screen. If there's a significant difference between primary and proof velocities, the M35 waves a flag. If the spacing between screens is incorrect, expect larger (but fairly consistent) differences on each shot. For example, if you move the proof screen more than a quarter inch from the exact midpoint, you will see the flashing display. The proof channel shows the importance of accurate and adequate screen spacing. The proof channel can't measure screen spacing for you, but it sees your errors. The size of the differences on each shot is comparable to the size of typical errors in your velocity measurements. The proof channel tells you when to trust the chronograph velocity reading, and when the system is fooled by light conditions.

We could have made the proof channel so that the differences would be much smaller. For instance, if you use only two screens to drive two chronographs; they will read the same on each shot and prove nothing. An error at either screen causes an identical error in velocity for each chronograph. You can use two pairs of screens with both start screens adjacent and both stop screens adjacent. You get maximum spacing on both pair, but conditions will likely affect both pair in the same way and still prove little. The configuration of the M35 was chosen so that an error at any one or two skyscreens causes a *difference* in velocity readings. This difference is your warning of a measurement error.

SKYSCREEN BACKGROUND

We've shipped Skyscreen III units with Oehler chronographs since 1984. Thousands of shooters have been pleased. The Skyscreen III was the first handloader skyscreen to use lenses, and the units have been refined to near perfection. We improved the shielding of the cable so you'll see fewer false triggers from static electricity and electrical interference. We reinforced the rugged single-bolt mounting system so you can't pop the mounting bolt from the case.

For years other manufacturers ridiculed our use of diffusers; now our most vocal critics advocate diffusers and sell their imitations. We've gone a step farther and have improved ours for better performance. The new diffuser's special blaze orange material gives the highest sensitivity with early and late light. The translucent material tames the brightest noonday sun while the new wider diffuser and the new lens hood protects the lens from the glare of mid-day sun.

The diffusers won't flutter in the wind and they easily absorb the blast of the biggest guns. They will not survive direct bullet hits. Still, the side rails flex to protect your skyscreens if your mounting rail takes a tumble. All parts, including the skyscreen cases, are molded of tough polycarbonate. There's no metal to rust or kink, and there's no glue to fail. Best of all, the window is larger so they are easier to shoot through without fear of damage.

The 4’ rail provided with your system reflects our industrial experience. We know that longer is better. A one-foot spacing between screens in inherently twice as accurate as is a six-inch spacing. A two-foot spacing is twice as good as the one-foot spacing. The four-foot spacing is twice as good as the two-foot spacing. We stop there because we’ve found that that four-foot rail is as long as we can conveniently haul to the range. The rail includes dimples to hold three skyscreens at precise spacing. As you tighten the 1/4"-20 mounting screw of each skyscreen into its dimple you get exact screen spacing. Dropping the bolt tails into the tops of the stands may appear crude, but it works well and you need no tools at the range. The two folding stands are more convenient and reliable than is a single camera tripod.

PROGRAM SWITCHES

The programming switches for the Model 35P are normally set for use with the four-foot rail.

The settings of the program switches control the M35. You can select PRINTER ON or OFF, EDIT ON or EDIT OFF, and the screen spacing. The switches are inside next to the battery. Remove the battery compartment cover to see the switches. A pointed wooden stick is the best tool for changing the switch settings, and a ballpoint pen is second choice.

The first five switch positions (numbered 1 through 5) must match the distance between the widest screens, measured center to center. The chart below shows the switch settings for each spacing.

	1 ft	**2 ft**	**3 ft**	**4 ft**	**5 ft**	**6 ft**	**7 ft**	**8 ft**
SW1	ON	OFF	ON	OFF	ON	OFF	ON	OFF
SW2	OFF	ON	ON	OFF	OFF	ON	ON	OFF
SW3	OFF	OFF	OFF	ON	ON	ON	ON	OFF
SW4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON
SW5	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

	8 ft	**9 ft**	**10 ft**	**11 ft**	**12 ft**	**13 ft**	**14 ft**	**15 ft**
SW1	OFF	ON	OFF	ON	OFF	ON	OFF	ON
SW2	OFF	OFF	ON	ON	OFF	OFF	ON	ON
SW3	OFF	OFF	OFF	OFF	ON	ON	ON	ON
SW4	ON	ON	ON	ON	ON	ON	ON	ON
SW5	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

Turning Switch 5 ON multiples the screen spacing setting by 10, or causes the displayed velocity to be multiplied by 10. For example, if a precision air rifle gives velocities near 570 fps, turning Switch 5 ON causes a readout of 5714 instead of the expected 571. The 5714 reading corresponds to 571.4 feet per second. This switch is most useful for work in metric units where many velocities are under 999 meters per second and you want extra resolution.

Switch 6 controls the edit mode. If Switch 6 is ON, the edit or replay function is available. In the edit mode, the unit will store the results of up to 20 shots. You can replay shots during or after the test and individual shots can be omitted from the summary. With Switch 6 OFF, you can fire and summarize up to 255 shots. We ship the unit with the edit mode OFF.

Switch 7 is normally ON if you have a printer. You can turn the printer OFF to coax a few more shots from a weak battery or if you are out of paper. .

METRIC VELOCITIES

For readout in metric units, the screen spacing should be set at an increment measured exactly in meters. One meter is convenient, but two meters will give better accuracy. Use any rigid metal tubing with a diameter slightly less than 18 mm. Cut the tubing to 1.019 or 2.019 meters and mount the skyscreens flush with each end. This gives a spacing of 1.000 or 2.000 meters between centers. Set the distance switch as follows:

	1 m	**2 m**	**3 m**
SW1	ON	OFF	ON
SW2	OFF	ON	ON
SW3	OFF	OFF	OFF
SW4	OFF	OFF	OFF
SW5	OFF	OFF	OFF.

Switch 5 can be turned ON if all velocities will be less than 999 meters/second. This will cause readout in decimeters/second.

SKYSCREEN MOUNTING

Use the 4' rail with a light stand under each end. Mount start and stop skyscreens using a 3" threaded stud with attached wing-nut as the mounting screw. The long tail of each stud slips into the hollow center post of a stand. Make sure that the screws fit into the dimples of the rail. Tighten each thumbscrew and stud firmly by hand.

We prefer a 4' screen spacing for general use. If you must have longer or shorter rail, use half-inch EMT (thin-wall electrical conduit) cut an inch longer than the desired screen spacing. You can use longer screen spacing for improved accuracy, or a shorter rail for convenience. If you choose longer screen spacing, we suggest one that fits inside your vehicle for transport to the range. Regardless of the length of the rail, the third screen mounts midway between the two primary screens.

We discourage the use of two-piece rails. They usually sag at the coupling, and the uncertain sag cancels the benefits of the longer spacing.

It is convenient to "bundle" the cables from the skyscreens. Gather all three cables together near where the cable exits from the start skyscreen. Place a wrap of tape (electrical tape, masking tape, or whatever is handy) around the cables at this point. Repeat the tape wrap every foot until you get to the other end. The shortest cable end is obviously from the STOP screen; plug it in first. Plug the middle length cable into the MID jack. Finally plug the longest end into the START jack. Even if you remove the skyscreens from the rail, just coil the bundled cables "lasso" fashion and you'll have little trouble with tangles.

You must mount a diffuser over each skyscreen. Slip a black side-rail into your skyscreen, hook one end of an orange diffuser into the standing side-rail, hook a second side-rail onto the diffuser, and then slip the last end into the skyscreen.

ACTUAL CHRONOGRAPHING

After you mount the skyscreens for the first time, actual chrono-graphing is simple. Improper alignment not only leads to missed velocities, but often leads to bullet holes in the skyscreens. Place the assembled skyscreens approximately eight to ten feet in front of the muzzle. The triangular light diffusers should form a triangle-within-a-triangle sight picture as you look down the barrel at the target from your normal shooting position.

To align the skyscreens, sandbag a bolt action rifle aimed at your down-range target. Remove the bolt, and boresight back to the gun from the skyscreens. While boresighting, adjust the first (START) skyscreen until you look through the center of the window. Adjust height and move stand as required. Repeat with the STOP skyscreen. Verify the alignment by looking at the target from your normal shooting position. After the skyscreens are aligned, just shoot at the target. You can change guns (bolt actions, autos, lever actions, scopes or iron sights, or even handguns) just so you use the same fore-end rest and shoot at the same target.

You can use a similar procedure with a tripod. If you first align the start skyscreen, and then move the stop skyscreen into alignment, you'll find that the start skyscreen has moved in the opposite direction. That's why we prefer a stand under each end of the 4' rail.

Please don’t place armor plate in front of the skyscreens. Shooting next to armor placed near your face is hazardous and downright foolish. It is far better to blow a hole in a soft skyscreen than to deflect a round or to bounce it back in your face.

Connect the cables from the skyscreens to the input jacks of the M35P. Connect the far screen to the STOP jack, the middle screen to the MID jack, and the near screen to the START jack. **Make sure the plugs are pushed all the way into the jacks.** If you can see a band of metal between the plug body and the jack, plug it in farther. Plugging in the start screen switches on the M35. The printer will feed a few blank lines of paper when the start screen is plugged in. Place the M35 at a convenient location well behind the muzzle to protect it from muzzle blast. Ideally, the M35 should be placed as far back as your shooting shoulder.

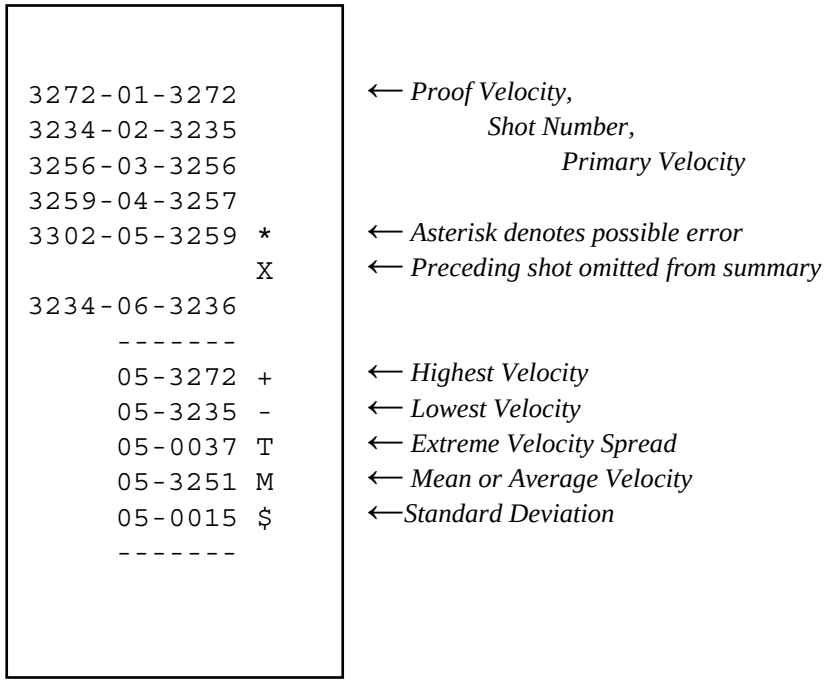
The display reads **---0** to show that it is ready to begin a new group. If the display doesn't read **---0**, push the RESET button. Fire through the center of the skyscreen windows. The unit will display the primary velocity and will print the proof velocity, shot number, and primary velocity. If no printer is in use, the unit flashes the round number **0001** and then displays the primary velocity. The unit resets itself and is ready for the next shot when the printing stops and a velocity is displayed. The velocity remains on the display until you fire the next shot or omit the velocity from the summary with the OMIT pushbutton. If the velocity is omitted, it is erased from the memory and the display shows ----.

If you are using the third skyscreen, the system compares the primary velocity and the proof velocity. If the difference between velocities is larger than expected, then the display will blink the velocity reading and the printout will include an asterisk *****. Even with no printer, the system still measures both velocities and compares them. The display will still be steady if there is no significant difference between the primary and proof velocities, and the display will flash or blink if there is a significant difference. The error could be caused by inaccurate screen spacing (more than 0.25 inch error in mounting distance, or a bent rail), shooting a BB or pellet too high in the screen window, muzzle blast ahead of a subsonic bullet, inadequate light, abnormally bright bullets, or the "glints" caused by excessive light reflecting from the bottom halves of the bullets.

PRINTER OUTPUT

The M35P was designed for use with the built-in printer. The printer is the only means of displaying the velocity measured in the proof channel, and it is convenient not to write down numbers after each shot. Chronographs with printers are nothing new to Oehler; we've been making them for industrial users for over forty years. We have maintained one absolute requirement; the printed record must always reflect a complete record of the test. Editing removes individual shots from the next statistical summary, but the data remains in the record. The scientist crosses out data in his records; he doesn't erase it. The printed output from the M35 saves all the velocities. You will have the data later if you need it. Just because you don't expect a particular velocity doesn't mean it is wrong.

Shown below is a typical output tape from the printer:



SUMMARY

After you have fired a test lot of ammo (up to 20 rounds in the edit mode or 255 rounds with the edit off), the M35 will summarize the test. With the printer in use, one push of the SUMMARY button causes the entire summary to print. The printed summary shows the high velocity (+) the low velocity (-), the extreme velocity spread (**T**), the mean or average velocity (**M**), and the standard deviation (**$**). The printed round number in the summary refers to the number of valid rounds considered in the summary. The summary ends with a display of **----** showing that more rounds can be fired and added to the data for a later summary.

If the printer is not in use, pushing the SUMMARY button briefly displays **Shot** and then the number of rounds considered in the summary. The next push of the SUMMARY button gives **HI** and the high velocity, . . . **LO** and the low velocity, . . . **ES** and the extreme velocity spread, . . . **A** and the average velocity, . . . **Sd** and the standard deviation, and finally **----** is displayed showing that another round may be fired.

If you fire large lots of ammo (more than 10 rounds), it is prudent to stop and record the summary at intervals during the test. If the test is interrupted, you will at least have partial statistics.

Only the primary velocities are summarized. The accuracy of the primary channel is normally twice that of the proof channel, and the summary of the primary velocities is most significant.

BATTERY

The nine-volt alkaline battery used in the Model 35P is the same size commonly used in radios and smoke detectors. The word alkaline is very important. Many junk batteries are labeled with Heavy Duty, Industrial Strength, Super Power, or other impressive names. If the battery isn't alkaline, it probably won't work the printer. If you use a rechargeable "nine-volt" nicad battery, note that many are actually only 7.2 volts. Operation of the printer will be marginal.

A fresh alkaline battery typically powers a M35P for 25 hours including 1000 lines of printer use. The battery will typically power the M35 for 50 hours of operation without the printer. If a printer is in use, the state of the battery is obvious. With a fresh battery, the printer will print a line in approximately two seconds. With the battery almost exhausted, the printer slows to three or four seconds per line. The slow print speed does not affect the accuracy of the velocity measurement. The velocities shown are accurate until the printer just stops. Note: Just because you bought a new battery does not mean that it is a good battery, usually, but not always.

The battery compartment of the M35 holds two batteries, one active and one spare. Contrary to custom, Oehler ships the M35 with a battery installed. Consider this first battery to be the first of many spares, and always keep a spare battery in the M35. Always use the spare to replace a dead battery, and don't forget to replace the spare with a fresh battery. A spare at home in the smoke detector doesn’t count on the range.

The M35 has no ON/OFF power switch. Over the years we've found that the most likely cause of a dead battery is putting away a unit with the power switch left on, or the power switch being turned on accidentally. We've missed the velocities of many shots because we had our chronograph turned off. The M35 turns on when the start skyscreen is plugged in, and it is off when the start skyscreen is unplugged. You aren't likely to transport or store your unit with the screens plugged in, and the screens won't plug themselves in.

EDIT MODE

The edit mode provides a replay of the velocities in a group, and allows you to omit one or more velocities from the summary. We provide both an edit mode and a switch to cancel the edit mode. You must select or cancel the edit mode before the skyscreens are plugged in. You cannot change modes after a test is started.

In the edit mode you can shoot and observe velocities in the usual fashion. At any point during or following a group, you can begin the edit function by pushing the RESET/EDIT button once. The display will show **Edit**. Begin the velocity replay by pushing the SUMMARY/STEP button. It will show shot **0001** and the velocity. You can omit this shot from the summary by pushing the OMIT button, or step to the next shot with the STEP button. Step through the group by pushing the SUMMARY/STEP button or the OMIT button at each shot. When the display shows **----** you can fire more shots, repeat the replay and edit, or reset the unit by pushing the RESET/EDIT button twice. The unit is ready for new group when the display shows **---0**.

Use the edit function as an aid to calculating a summary. You can't use it to forget undesirable data and print a clean tape. When a shot is omitted with the edit, it is not forgotten. It is excluded from the following summary. The velocity remains in memory and reappears if the group is replayed again. For example, if you fired two five-shot groups and recorded them as one ten-shot group, you can still get a separate summary for each five-shot group. Edit the group, omitting the last five shots, and you get a summary of the first five shots. Edit again, omitting the first five shots, and get the summary of the last five shots. The unit stores a maximum of 20 shots in the edit mode. After it has recorded 20 shots, the display indicates **FULL**. At this point you can edit and summarize, but you can't add any more shots.

Too complicated? Leave Switch 6 OFF, and forget about the edit mode. Some of us still dislike computers and can't remember how to set our digital watch.

PRINTER PAPER

The M35P uses standard 2.25 inch wide plain adding machine tape. The M35P has an internal box to contain a small roll of paper instead of using the external rack to hold a large roll. It's much easier to transport and use at the range. Several portable calculators use these small rolls, but it is much easier to find the standard large rolls. You can easily make four or five small rolls from one inexpensive large roll. Simply strip five arm-spans (twenty-five or thirty feet) of paper tape from the big roll, roll it up tightly, and snap a rubber band around it**. The paper will feed into the printer easier if you square the end with scissors and cut a half-inch triangle from each corner.** Repeat until the big roll is gone and you will have a good supply of paper in small rolls. If you think this is a nuisance, just look for thermal paper when you buy your roll of plain adding machine tape at a local store. Plain paper is inexpensive, readily available, and the printing does not disappear with age.

To load the paper tape into the M35, remove the wire clip at the back of the paper box. Plug in the start screen to turn on the M35. Feed the cut end of the paper tape into the printer slot at the back of the paper box and push any button to generate paper-feeds. The paper feeds best from the top of the roll. After the paper threads through the printer, place the roll in the paper box and replace the wire retainer clip.

If the printer ink roller gets dry and the print is too dim, replace the ink roller. Many battery-operated portable calculators use the same print mechanism. Take your ink roller along to your local office supply store and ask for a roller to fit a hand-held calculator. They are usually available and will often be labeled *PR-40* or similar. If you can't find the roller locally, a scant drop of stamp-pad ink applied to the foam roller will work. Lacking stamp-pad ink, you can always try a light mist of WD-40 on the foam roller. If all else fails, call Oehler to order a replacement.

A full big roll of paper can be mounted externally with the included wire bracket. To mount the bracket, start with the straightest end of the wire bracket inside the paper box. Twist and feed the bracket through the side hole until the straight end forms an external hanger for a paper roll. Hook the crooked end of the wire through the small hole previously used for the paper-retainer clip. Save the paper retainer clip in case you want to again use the smaller rolls.

IN CASE OF TROUBLE

If the display does not change when you shoot, it means that no start signal was received. Possible causes are the bullet passing too near the top or side of the skyscreen window, the orange diffuser not being directly illuminated by the sun, the skyscreen not having an unobstructed view of the sky overhead, or having too little light for proper skyscreen operation. Make a deliberate effort to shoot through the middle of the triangular window of the Skyscreen III. Shoot airguns and arrows approximately one-third of the way up the window. Be sure the skyscreen cables are plugged firmly into the jacks on the back of the M35; if you can see a band of metal between the plug handle and the jack, it's not plugged in good.

A display of ---0 has special significance; the chronograph is reset and no shot has been recognized.. The similar display of ---- shows that the M35 received a start signal, but didn't get a stop signal corresponding to a legitimate velocity, and is anticipating the next shot. You will get this display if you have the cable from the stop screen plugged into the start input, if the start screen receives a stray input signal before a shot is fired, if the stop screen isn't plugged in, or if the stop screen doesn't see the bullet. You can test individual skyscreens by plugging only one screen into the START input. With a good skyscreen, the display should go to ---0 when you plug it in, remain at ---0 until you shoot a BB or 22, and then change to ----- when you shoot and the skyscreen sees the bullet.

The printout of **9999** indicates that the M35 received a start signal and then a quick stop signal so that the velocity was higher than **9999**. You are most likely to get this printout between actual shots if there is severe electrical noise in the area. If the printout shows either **----**, **0000** or **9999**, you don't have to push the OMIT button. The unit knows the velocity is wrong and it's automatically omitted from the summary.

If the M35 displays a velocity before you shoot, it was probably caused by static electricity. Skyscreens are sensitive to the same electrical noises that cause static on an AM radio. Typical causes are synthetic clothing in dry weather, nearby high-voltage power lines, large appliances with electrical motors or solenoids turning on or off, electric fences, or radar and radio transmitters. Muzzle blast from adjacent benches can also trigger the skyscreens.

You may be concerned by differences between the primary velocity and the secondary velocity. If an asterisk is printed to the right of the velocities, the system considers the differences are large enough for concern. The allowed velocity difference becomes larger with shorter screen spacing and higher velocity. If the middle screen is off-center by more than 0.25 inch, or if it misses seeing the tip of the bullet by 0.25 inch, you will get the asterisk warning. If the proof channel velocities are consistently high, then the middle screen is probably mounted too near the start screen. If the proof channel velocities are consistently low, then the middle screen is probably mounted too far from the start screen.

If you are tempted to use short screen spacings or to not bother with the diffusers over the skyscreens, fire a few ten shot groups to compare long spacing versus short spacing and diffusers on versus diffusers off. Note the difference between primary and proof velocity on each shot. While averages usually remain close to the same, you will see the differences get larger as you eliminate the diffusers and decrease screen spacing. Watching the consistency diminish with shorter screen spacing and poor light will make you want to use diffusers and the longest practical screen spacing. You will be able to see some differences with an air rifle or .22 LR. The contrasts are even more dramatic if you use a varmint rifle.

You can quickly check the operation of your chronograph system with an airgun. Velocities will range from approximately 225 fps for a kid's BB gun, to approximately 600 fps for adult match air rifles, up to over 1000 fps for some adult sporter air rifles. BBs and pellets are small, short, and slow. They provide a severe test of skyscreen sensitivity, so you must shoot through the lower half of the skyscreen window. If your system works with an airgun, but fails with larger guns, you can suspect problems related to muzzle blast or flash.

If your Model 35 doesn't work, call us at 512 / 327-6900, Monday through Friday, 8 am until 5 pm. We've cured hundreds of chronograph problems over the phone and are anxious to help. Thanks for reading the instructions.

GLINTS

If you look at a bullet illuminated by a light from the side, you can see a small "glint" of light reflected from the ogive. This reflected light can cause the bullet to appear as a momentary bright spot over the skyscreen instead of the expected dark spot silhouetted against the sky. The patented Oehler GLINT PROOF skyscreens recognize either the light spot or a dark shadow caused by the bullet. Under certain conditions, the reflected light is approximately equal to the shadow. When the glint and shadow are approximately equal, they cancel and skyscreen performance is erratic. These difficult conditions are detected by the proof channel; you must change the conditions or simply wait for a better day.

The glint phenomenon occurs primarily under clear skies. Unless the sun is shining directly on the orange diffusers, the amount of light from a clear sky is typically one-fourth the light from a cloudy or hazy sky. Skyscreens will adapt to this lower light level just as does a camera with automatic exposure control, but they work better with more light. The diffuser makes an "artificial cloud" above the bullet and converts the direct light from the sun to the diffuse light needed by the skyscreens.

Glint problems also show up when shooting over snow or light sand. The bottom of the bullet is illuminated by light reflected from the ground, and the bullet appears to be almost as bright as the sky. The only positive solution for the glints is to shade the bullet from light as it passes through the skyscreen window. Only if no light strikes the bottom half of the bullet are you absolutely sure that there are no glints.

Skyscreens want to see a dark bullet silhouetted against the bright back-ground formed by the diffuser illuminated by direct sun. If there's not enough light on the diffuser, or if the bullet is exceptionally bright, you can expect problems. Beautifully polished bullets are often difficult to chronograph. It is sometimes effective to blacken the ogive with a black felt-tip marker. Dull the mirror finish of the bullet with steel wool before you apply the black ink.

ORANGE DIFFUSERS CAN'T ALWAYS HELP

The orange diffusers shade the lenses from noonday sun and make the hot-spot light from the sun into a uniformly bright orange background against which the eye can see the bullet. If you are shooting under cloudy skies, with heavy overcast, or in the shade, then no direct light strikes the diffuser. What little light is available is already diffused, and the diffuser can't make it any brighter. If the orange diffusers don't cast a shadow, and you have problems, try leaving them off. You can still use the black side-rails as aiming guides.

Expect trouble if you try to shoot under the shade of a tree. The sun can cast a spotted shadow on the diffuser; the bullet may go through a bright spot and be detected or the bullet may go through a shaded spot and be missed. With no diffuser, the eye may see the bullet silhouetted against a spot of sky, or the bullet might be silhouetted only against the black bottom of a limb.

SUBSONIC VELOCITIES

With velocities below the speed of sound, the muzzle blast wave reaches the screen before the bullet. This muzzle blast wave is like a lens traveling through the air at the speed of sound, and the resulting light diffraction can trigger the skyscreens. (The speed of sound is approximately 1060 plus the air temperature in degrees Fahrenheit, or 1130 fps at room temperature.) Premature triggering of only the start screen will cause both velocities to be abnormally low and the difference to be high. Premature triggering of both start and middle screens will cause the primary velocity to read abnormally low and the proof velocity to read the speed of sound. Premature triggering of all three screens (a rare case) will cause both primary and proof velocities to read the speed of sound.

If you see the effects of blast, the only sure solution is to install a blast baffle midway between muzzle and first screen. This baffle should be a piece of plywood with a small hole or vertical slot to shoot through. We use a 2x4' piece of plywood standing on end and supported by a single hinged leg. Cut a vertical inch-wide shooting slot from bench level to the top of the shield. Occasionally blast problems can be cured by moving the skyscreens farther from the muzzle or by slightly changing the shooting direction.

BOWS

The M35P with Skyscreen III detectors works well for archery. Make sure that the screens are far enough away that the arrow leaves the string before the point gets to the first screen. Blunt points work best, followed by round points and target points. Needle-like field points and broad-heads can give erratic results. The skyscreens need to see an abrupt change in light. Because arrows are slower than bullets, you must help the skyscreens by using a flatter nose.

SHOTGUNS

The system can be used for shotshells. It reliably measures the velocity of the front pellets in the shot string. These velocities are typically 2% to 5% higher than factory measured velocities. The factory systems (also made by Oehler) use inductance sensing coils to measure the velocity of the large clump of shot at the back end of the shot column. A primary screen spacing of four feet is best for shotgun work. The first screen should be placed three or four feet from the muzzle. You will get the most consistent and accurate results if you use the most open choke available.

You must wear safety goggles while shooting!

INDOOR SHOOTING

To use skyscreens indoors, you must provide a substitute for the daylight. Use a reflector type incandescent lamp shining down on the top of the diffuser of each skyscreen. You must use incandescent lamps; fluorescent lamps will not work! Mount the lamps just high enough to uniformly illuminate the diffuser. Common utility reflectors with 60 to100 watt bulbs work fine. The 90 or 150 watt PAR outdoor reflector lamps with their heavy glass envelopes will better resist muzzle blast. Using the Skyscreen III units indoors with lamps will work most of the time. Adding lamps to our skyscreen type system will not give you all the advantages of our laboratory type systems. Our laboratory systems cost more, and they perform better.

DOWNRANGE VELOCITIES

The Model 35P with printer is appropriate for measuring downrange velocities. To measure ballistic coefficients, use one M35P at the muzzle and a second one downrange. Accuracy is critical, so a spacing of at least 4 feet is preferred and 8 feet is still better. Verify system accuracy by first shooting with both systems near the gun to assure that the readings agree on each shot. Then move the downrange system without disturbing screen spacing adjustments. For the best results, use Oehler's **Ballistic Explorer** computer program to calculate the ballistic coefficients and to project downrange performance of your loads.

MUZZLE VELOCITIES FROM INSTRUMENTAL VELOCITIES

The velocity recorded by the chronograph corresponds to the velocity at the midpoint of the screens. This velocity is lower than true muzzle velocity by the amount of velocity lost between the muzzle and the midpoint of the screens. Typically the midpoint is 12 feet or 4 yards from the muzzle. Look in the tables provided by the ammo or bullet manufacturer to find the velocity lost in the first 100 yards at your approximate velocity level. Divide the 100 yard velocity loss by 25 to find the loss in 4 yards. Add the 4-yard loss to your chronograph reading to get muzzle velocity.

WOUNDED SKYSCREENS

It is not feasible for us to repair wounded skyscreens. It often costs more to repair a skyscreen than to make a new one. Naturally we will repair or replace at no charge any defective skyscreen returned to us. We accept full responsibility for defective parts or workmanship, and you are responsible for bullet holes. Oehler has available extra plastic cases, lenses, and diffusers for those who nick their screens and want to make their own repairs. If you shoot the "eye" or the cable of the screen, consider it dead.

STANDARD DEVIATION AND LOAD DEVELOPMENT

What is standard deviation and what does it mean? Because standard deviation and average go hand-in-hand, let's first talk about averages. If you talk about average velocity, everyone knows what you mean. You measure the velocity of several shots and you average your readings. If someone asks you the velocity of that ammo, you say that it's about 2950 feet per second. You naturally quote the average velocity, and the listener understands. You know that some shots will be faster than average and some will be slower. You don't even worry about the exact definition of average; it's about the middle.

Confusion doesn't come until someone asks if the velocity is uniform. You are comfortable with quoting the average velocity, but you know that it doesn't tell the whole story. The average does not tell you how much the velocity readings scatter above and below the average. How do you describe uniformity or assign it a number grade? The standard deviation is a number that describes uniformity. The smaller the number, the more uniform the velocity. A standard deviation of zero means every velocity was the same. A standard deviation of 28 fps means you expect two-thirds of the individual velocities to be within 28 fps of the average.

Mathematicians and statisticians have talked about uniformity for years. They may call the lack of uniformity *dispersion* or *variance*. They may talk about the difference between highest and lowest and call it range, extreme variation or extreme spread. They may talk in terms of the coefficient of variation. They prefer to talk and think in terms of standard deviation. Standard deviation is the best measure of uniformity, and it fits recognized procedures, equations and textbooks.

Modern shooters consider standard deviation as the best measure of velocity uniformity. In the past, shooters used extreme spread or mean absolute deviation as the indicator of uniformity. This was a matter of pre-calculator convenience. Statisticians knew that standard deviation was a better measure of uniformity, but nobody wants to calculate it manually. If you've never computed standard deviations manually, be assured that the pleasure ranks right up there with spit-shining combat boots. You avoid it if at all possible. With machines to do the tedious calculations, we can now all use standard deviation as the measure of uniformity.

Consider what happens when you test a handload. You hear it go bang, you feel the recoil, you see where it hits the target, and you can measure the velocity. We normally don't measure the intensity of the bang or the force of the recoil; we measure only the target and the velocity. Most important is where the bullet hits the target. If all the bullets go into the same hole, and the average velocity is sufficient, you don't worry about velocity uniformity. If the group is larger than you want, you grasp at anything that will give you a clue of what went wrong.

The secret for making smaller groups is uniformity. Other things being equal, the more uniform you can make the ammo, the more likely it will shoot to the same hole. Uniform velocities are simply another indicator of uniform ammo. Uniform velocities do not guarantee small groups, nor do large variations guarantee large groups. There are no guarantees, but you can at least put the odds on your side. When you have uniform velocities you can assume that you have a proper primer for the powder, that you have a reasonable powder for the case and bullet, you did a good job measuring the power, and that your cases were of uniform capacity. Uniform velocities tell you very little about bullet quality, the bedding of the action and barrel, or if the gun vibrations induced by the firing just happen to fall in a sweet spot. When you have erratic velocities and small groups, your bedding is probably good and you have a good average velocity for that powder/bullet combination, but be suspicious of your primer choice and firing pin. If you get both erratic velocities and large groups, go ahead and make significant changes in bullet, powder type, or gun; you probably aren't close to any perfect combination.

The common limitation on the formal use of standard deviation and other statistical procedures in shooting is the number of shots required. Statisticians call it sample size. Invariably statisticians ask for more shots than shooters want to fire. Shooters want to shoot five-shot groups, and statisticians want to see at least twenty-shot samples. Firing more shots into a group will give you a better statistical measure of both the accuracy and the standard deviation.

Trying to measure the velocity uniformity of your ammo by chronographing only five shots is like measuring the accuracy with one five-shot group. One group is an indication, but you can't trust it to repeat. Likewise, one standard deviation number should be considered only as an indication of uniformity. Although standard deviation is the best available measure of velocity uniformity, it is not good enough to be considered the only measure of ammo quality. Use standard deviation numbers as indicators of uniformity, but use them along with other indicators of load performance.

Do you always need to use a large sample size as you are developing your loads? When I shoot a large group, backed up by large standard deviation, I don't waste time trying to measure just how bad the load is. The load could eventually prove to be a good one, but the odds are against it. I'm looking for good loads, and abandon bad loads as quickly as possible. With the large standard deviation confirming the large group, I abandon the load quickly and don't feel guilty for shooting fewer than twenty shots. It's fun to shoot a new load that I hope is good; it's drudgery to shoot a load which I expect to be bad.

Sample size takes care of itself with good loads. If a load looks good, even though you've fired only one five-shot group, you don't abandon it and you don't immediately accept it. You try at least two or three more groups of this load to see if it is golden. The original sample of five shots is now fifteen or twenty shots. If the load continues to look good, you load and shoot it still more. Even a statistician would be happy with the total number of shots fired with your "keeper" loads.

What are reasonable values for standard deviation? What's a good group size or a good average velocity? It all depends on what you're trying to do. You should use the numbers only for comparison, and you don't compare apples and oranges. If you're working up an elk load for a .375, comparisons to the performance of your .45 ACP or varmint rifle are irrelevant. You don't compare the average velocity of your .375 to the average velocity of your .45 ACP. You don't compare groups from your .375 to the groups from your varmint rifle. Likewise, you don't compare standard deviations between your .375 and the other guns. The only comparisons that matter are those you make between the .375 loads you keep and the .375 loads that you abandon.

What do you do with the group sizes, average velocities, and standard deviations reported by another shooter? His results can influence which loads you select for trial. Choosing a load that's listed in a manual and also worked for him beats choosing a random load. After you've tested the other shooter's load, his results should not sway your decision. What counts is how the load performs in your gun, when compared to other loads in your gun.

Some shooters question the use of standard deviation in load development. We agree that velocity uniformity or standard deviation should not be the only criteria used in selecting a load. Standard deviation must be considered along with everything else you know about the load. Note that the measured standard deviation includes variations in both the ammo and the chronograph. Chronograph systems with inadequate spacings between skyscreens often give passable readings of average velocity, but questionable readings of standard deviation. Whenever you use standard deviation, remember there is an important corollary of Murphy's law. Its regular use can replace many mathematical theorems and complicated statistical procedures.

Large groups usually repeat;
Large groups with large standard deviations always repeat;
Small groups caused by luck never repeat.

CARRYING CASE

The carrying case is obviously a double rifle case. We have used similar cases over the years and have found them very convenient. When you take it to the range, you have the entire system. You might even have spare paper and battery tucked away. We experimented with individual pockets for each item, but found that the single padded pocket for the Model 35P along with the large area in which to toss all incidental items was the most convenient.

If you are using the large paper roll, you must remove it to fit the Model 35P into the case. We usually remove the paper roll from the hanger but leave the paper threaded through the unit. Sometimes rethreading the paper can be difficult, but it is easy enough to restore a wrap or two on the paper roll.

One trick that many users have found convenient is to leave the skyscreens on the rail. Remove the diffusers, then loosen start and middle screens and slide them against the stop skyscreen. Loosely coil the cables and place the rail with screens in the case. It will make assembly of the screens and rail much easier next time you use it.

Add the folded stands and the diffuser pieces. The foam in the top of the case will keep everything together when the case is closed.

SPECIFICATIONS

SKYSCREEN CHARACTERISTICS:

Shooting Area	103 sq in
Active Area	84 sq in
Beam Width	30 degrees
Beam Thickness	0.1 inch
	(6 inches above unit)

SCREEN SPACING:

Minimum spacing of 1 foot is *allowed*; minimum spacing of 2 feet is *recommended*. Spacing of 4 feet is *suggested* for high velocity rifles. Spacing of primary screens can be set from 1 to 15 feet and from 10 to 150 feet in increments of 10 feet; proof screen is always set midway between primary screens.

PRINTER:

The optional built-in printer prints with real ink on standard 2.25 inch plain paper. It prints primary velocity, round number, and proof velocity as each round is fired. It prints statistical summary of primary velocity.

TEMPERATURE OPERATING RANGE:

0^{o} to 50^{o} Centigrade
32^{o} to 122^{o} Fahrenheit.

Systems typically operate at temperatures down to 0^{o}F or -18^{o}C if the battery can supply reliable power.

BATTERY:

A single nine-volt NEDA 1604 alkaline battery is supplied. A fresh battery will operate the system for up to 25 hours including 1000 print lines. Internal battery compartment includes space for spare battery.

EDIT MODE:

An edit mode allows for instant replay of up to twenty shots. During replay you can omit questioned shots from the summary.

CRYSTAL OSCILLATOR FREQUENCY:

4.0 MHz oscillator for 0.25 microsecond time resolution.

ACCURACY:

The expected error on any one shot depends on both velocity and screen spacing. Typical errors are shown in the table. The table assumes good light conditions, dark bullets, exact screen spacing, and shooting through the center of the Skyscreen III window. Actual errors under your shooting conditions will be reliably indicated by the *PROOF CHANNEL*.

	1 FT	**2 FT**	**4 FT**	**8 FT**
1000 FPS	5 fps	3 fps	1 fps	1 fps
2000 FPS	10 fps	5 fps	3 fps	2 fps
3000 FPS	16 fps	8 fps	4 fps	2 fps
4000 FPS	21 fps	10 fps	5 fps	3 fps

You will typically see the above errors as differences between the primary and proof channels of a Model 35P as you shoot under "normal" conditions.

PROOF CHANNEL:

The system alerts you with a flashing display and printed asterisk if there is a significant difference between the two velocity readings. Differences which trigger the alert are shown for typical velocities and screen spacings.

	1 FT	**2 FT**	**4 FT**	**8 FT**
1000 FPS	42 fps	21 fps	10 fps	5 fps
2000 FPS	83 fps	42 fps	21 fps	10 fps
3000 FPS	125 fps	63 fps	31 fps	16 fps
4000 FPS	166 fps	83 fps	42 fps	21 fps

Notes:

WARRANTY

If your Oehler chronograph or skyscreen doesn't work, we'll fix it or replace it.
If you aren't satisfied, we'll refund your money.

We have honored this simple warranty for over forty years. Our written warranty has been limited to three years, but we've repaired many units at no charge even though some were fifteen or twenty years old. Our customers are reasonable; if they shoot a screen, smash a chronograph, or something just wears out, they expect to pay for repairs and we fix it at cost.

OEHLER
Model 35P